15:57:43 OCA PAD INITIATION - PROJECT HEADER INFORMATION 11/07/96

Active

Project #: E-20-M53 Cost share #: Rev #: 0
Center # : 10/24-6-R0172-0A0 Center shr #: OCA file #:
Work type : RES
Contract#: N47408-96-M-8397 Mod #: Document : PO
Prime #: Contract entity: GTRC

Subprojects ? : N CFDA:
Main project #: PE #:

Project unit: CIVIL ENGR Unit code: 02.010.116
Project director(s):
FROST J D CIVIL ENGR

Sponsor/division names: NAVY / NAVAL FACILITIES ENG COMM, PA
Sponsor/division codes: 103 / 046

Award period: 960930 to 970930 (performance) 970930 (reports)

Sponsor amount	New this change	Total to date
Contract value	24,975.00	24,975.00
Funded	24,975.00	24,975.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: LIQUEFACTION POTENTIAL MAPPING USING A SPATIAL & ANALYSIS SYSTEM

PROJECT ADMINISTRATION DATA

OCA contact: Jacquelyn L. Bendall 894-4820

Sponsor technical contact	Sponsor issuing office
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BLDG 41, CODE 2713	BLDG 41, CODE 2713
NCBC 1000 23RD AVE	NCBC 1000 23RD AVE
PORT HUENEME, CA 93043-4301	PORT HUENEME, CA 93043-4301

Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A N/A supplemental sheet
Equipment title vests with: Sponsor GIT X

Administrative comments -
INITIATION OF FIXED PRICE PURCHASE ORDER. MODIFICATION NO. P00001 DELETES DEFAULT CLAUSE.

Closeout Notice Date 02-OCT-1997

Project Number E-20-M53 Doch Id 40216

Center Number 10/24-6-R0172-0A0

Project Director FROST, JAMES

Project Unit CIVIL ENGR

Sponsor NAVY/NAVAL FACILITIES ENG COMM, PA

Division Id 3335

Contract Number N47408-96-M-8397 Contract Entity GTRC

Prime Contract Number

Title LIQUEFACTION POTENTIAL MAPPING USING A SPATIAL & ANALYSIS SYSTEM

Effective Completion Date 30-SEP-1997 (Performance) 30-SEP-1997 (Reports)

Closeout Action:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	
Final Report of Inventions and/or Subcontracts	N	
Government Property Inventory and Related Certificate	N	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

Comments

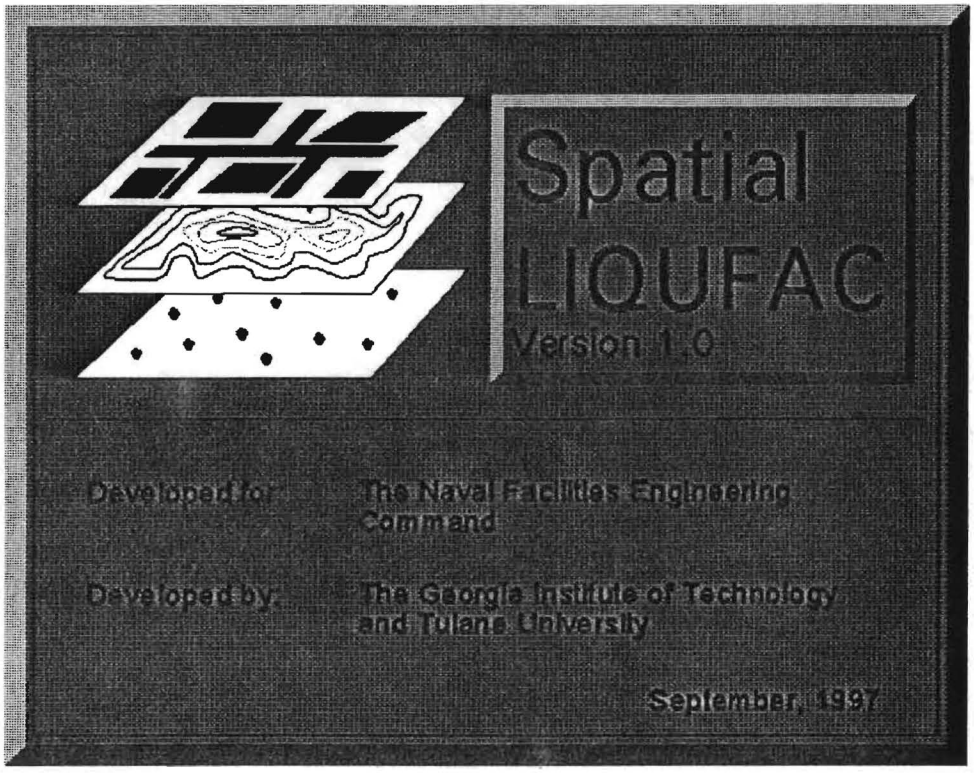
-

Distribution Required:

Project Director/Principal Investigator	Y
Research Administrative Network	Y
Accounting	Y
Research Security Department	N
Reports Coordinator	Y
Research Property Team	Y
Supply Services Department	Y
Georgia Tech Research Corporation	Y
Project File	Y

E-20-M53
#1

EARTHQUAKE HAZARD ASSESSMENT



USER MANUAL

Prepared by: Daniel P. Carroll, Georgia Institute of Technology
Dr. J. David Frost, Georgia Institute of Technology
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CHAPTER 1: Introduction

This chapter includes an overview of the Spatial LIQUFAC program, a brief description of how Spatial LIQUFAC works, and what features are available in Version 1.0.

- What is Spatial LIQUFAC ? 2
- How does Spatial LIQUFAC work ? 2
- About Spatial LIQUFAC Version 1.0 2

What is Spatial LIQUFAC?

Spatial LIQUFAC is an earthquake hazard analysis system which was developed by The Georgia Institute of Technology and Tulane University for the U. S. Naval Facilities Engineering Command. The system operates from within the Geographic Information System (GIS) software ArcView® 3.0 by ESRI, and can predict the earthquake induced post-liquefaction vertical settlement over a site specific area using information contained in borehole logs that include Standard Penetration Tests (SPT).

How does Spatial LIQUFAC Work?

The program LIQUFAC Version 2.00, which performs liquefaction potential analysis under earthquake loading and calculates the vertical settlement at a specific borehole, was developed for the U. S. Naval Facilities Engineering Command by Information Dynamics Inc. and Prototype Engineering Inc. in January 1994. Spatial LIQUFAC is an enhanced version of LIQUFAC 2.00 which can be run from within the ArcView® 3.0 GIS environment.

Spatial LIQUFAC is an environment where the user can easily query the spatial database of SPT boreholes and geotechnical engineering information for a specific site and prepare appropriate input files for each borehole. These files are then processed through Spatial LIQUFAC to predict the vertical settlement that will occur at each borehole location under a specific earthquake scenario. These results are then read back into the GIS environment and a spatial database of the settlement information is created.

Through Spatial LIQUFAC, the user has the full capabilities of ArcView 3.0, which include the creation of settlement contours, and the ability to perform spatial overlays and analysis of the compiled settlement output data.

About Spatial LIQUFAC Version 1.0

Spatial LIQUFAC Version 1.0 has been designed and implemented as a site specific engineering program. Subsequent versions will include modifications so that the program is site independent. The program has been designed to run only for the U. S. Naval Facility at Treasure Island, California. The software incorporates the use of the Treasure Island Geotechnical Engineering Database developed by The Georgia Institute of Technology using data originally compiled by Geomatrix Consultants.

CHAPTER 2: Installation

This chapter includes a list of the system hardware and software required to run Spatial LIQUFAC, the installation procedure for a personal computer, and a brief description of how to get started using the Spatial LIQUFAC software.

- System Requirements 4
- ArcView® 3.0 Requirements 4
- Installation Procedure for a Personal Computer 4
- Getting Started 5

System Requirements

Spatial LIQUFAC Version 1.0 is optimally designed to run on IBM PC's and compatibles with a Pentium® processor using the Windows '95® operating system. The program files require about 1mb of hard disk space on the "c:" drive. At least 3mb of hard disk space is recommended to accommodate all of the project files that will be created while using Spatial LIQUFAC. It is recommended that the system also have at the minimum 16mb of memory (32mb of memory is preferred).

Important:	The Spatial LIQUFAC program files must be installed into the root directory on the "c:" drive. Spatial LIQUFAC will not run if these files are installed anywhere else on the computer. The screen resolution must be set to 1024 x 768 pixels in order for Spatial LIQUFAC to run optimally.

ArcView® Version 3.0

Spatial LIQUFAC is designed to run from within the ArcView® Version 3.0 GIS environment. It will not run in conjunction with any other GIS package. ArcView® Version 3.0 for Windows '95 must be installed on the PC. The ArcView® Extension Module "Spatial Analyst 1.0 is required for Spatial LIQUFAC to be able to create contours of the predicted ground settlements. All other features of Spatial LIQUFAC will run without the "Spatial Analyst" installed.

Installation Procedure for a Personal Computer

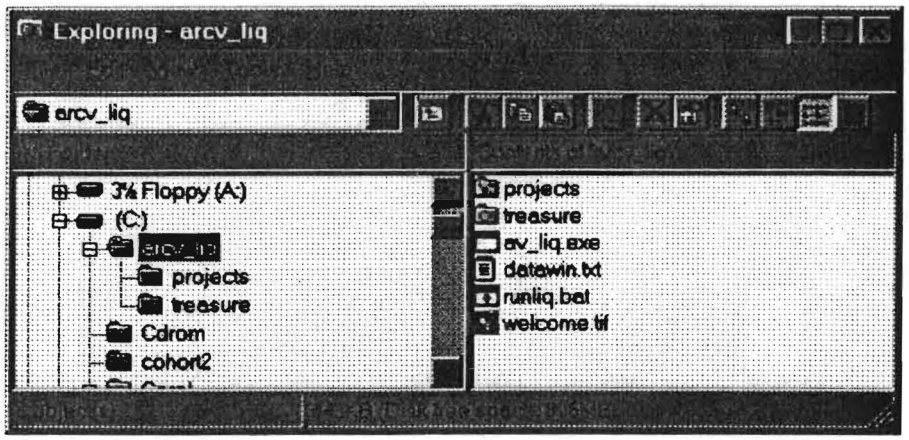
Perform the following steps to install Spatial LIQUFAC Version 1.0 on your PC:

1. Install ArcView® Version 3.0 GIS software and the "Spatial Analyst 1.0" extension module on your PC.

2. Insert the Spatial LIQUFAC program disk in your 3.5" floppy disk drive.

3. Copy the entire contents of the program disk directly into the root directory on your "c:" drive (see system requirements).

Following a successful installation, the contents of the "arcv_liq" directory should appear as shown below:



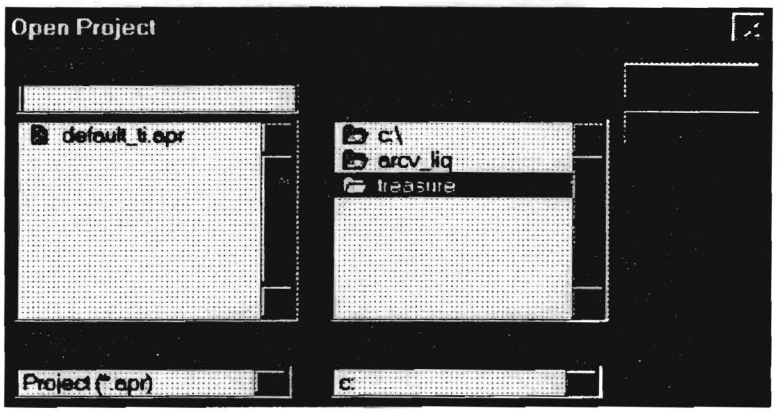
Getting Started

Perform the following steps to start a new analysis using Spatial LIQUFAC Version 1.0:

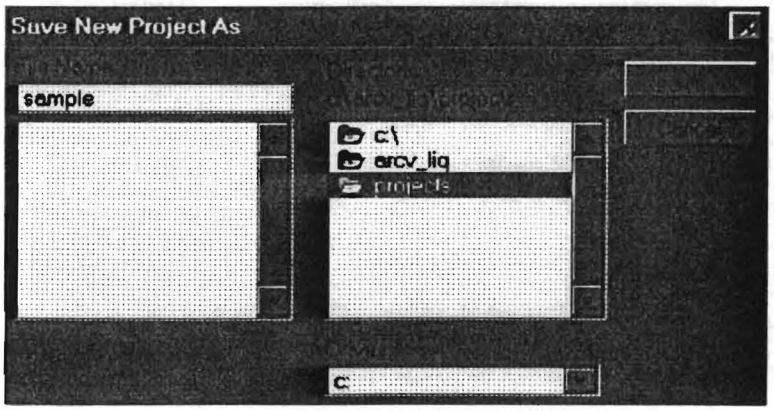
1. Start up ArcView® Version 3.0.

2. From the ArcView® "File" menu choose "Open Project".

3. Open the default project for Treasure Island. The correct location and name of this project file should be: "c:\arcv_liq\treasure\default_ti.apr". If you cannot find this file, check to be sure that the program files were installed properly (see installation procedure for a PC).



4. Spatial LIQUFAC will now start up and request for you to input a new project name. This new project must be located in the "c:\arcv_liq\projects\" directory. Use any file name you wish, but do not attach a file extension to the file name.



5. Spatial LIQUFAC is now ready for use.

The above procedure must be followed every time you wish to create a new project for use with Spatial LIQUFAC.

CHAPTER 3: Spatial LIQUFAC Functions

This chapter contains an introduction on performing an earthquake hazard analysis using Spatial LIQUFAC. The basic operating procedure is discussed and a brief description is given on each of the functions.

- Performing an Earthquake Hazard Analysis using Spatial LIQUFAC 8
- The Spatial LIQUFAC Process 8
- The Spatial LIQUFAC Menu 11

Performing an Earthquake Hazard Analysis using Spatial LIQUFAC

Before performing an earthquake hazard analysis using Spatial LIQUFAC, the user should have a comprehensive knowledge of geotechnical and seismic characteristics of the site to be analyzed (in this case Treasure Island). This should include at the minimum: familiarity with the geotechnical database, understanding the Treasure Island construction history and stratigraphy, experience with the Standard Penetration Test (SPT) procedure, understanding the dynamic response of soils found on the site, and knowledge of the regional seismicity. This program calculates an estimate of the vertical deformation that is likely to occur under a specific earthquake scenario. The inputs specified by the user throughout an analysis have a direct impact on the results generated by this program. The user is responsible for entering the appropriate information required for each analysis.

The Spatial LIQUFAC Process

The Spatial LIQUFAC process for generating an output shapefile† of vertical settlement contours for a given earthquake scenario includes four basic steps. A graphical representation of this process is shown on page 10.

- ***Borehole Selection:*** A set of SPT boreholes must be created for the site of interest. These can be selected from the Treasure Island Geotechnical Database by either using the map, the table, or combination of the map and the table. Any query procedure available to the user in ArcView® (ie. table query or spatial overlay) can be used to select the boreholes.

- ***Borehole Analysis:*** Once a set of boreholes has been selected, the user must perform a compilation of the geotechnical engineering soil properties. This can be a lengthy process since it can involve examining all of the available data for each borehole to select the appropriate information for the analysis. The borehole analysis produces the required Spatial LIQUFAC input files. After a set of boreholes has been analyzed, the user may add or remove boreholes from this set if desired.

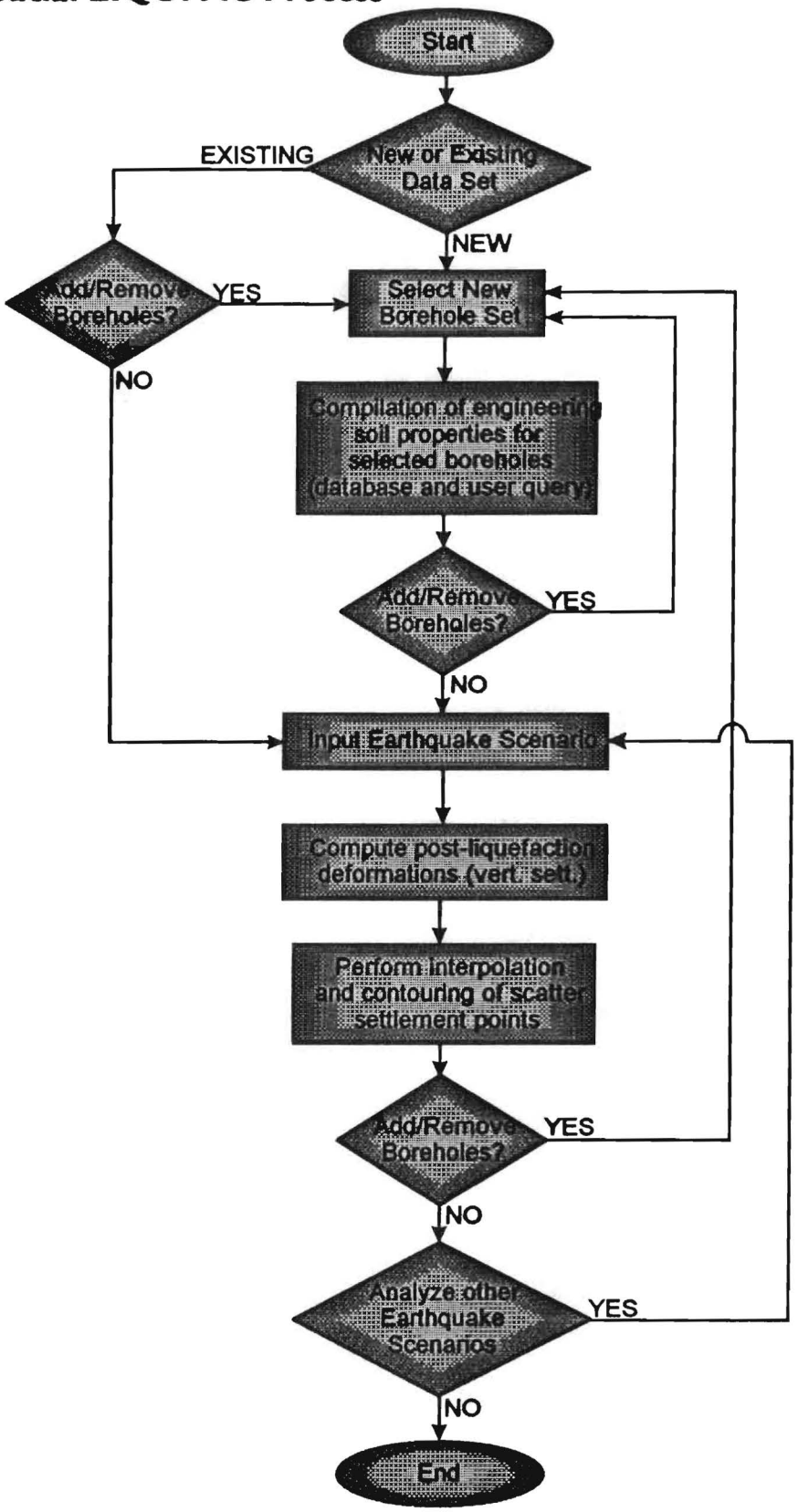
- ***Settlement Calculation:*** Next, the user enters the chosen earthquake magnitude and peak ground acceleration, and the Spatial LIQUFAC program is run to estimate the vertical settlement at each borehole. This step involves the creation of an output "point" shapefile containing the vertical settlement at each borehole from the Spatial LIQUFAC output files. This step may be repeated as many times as necessary to evaluate many different earthquake scenarios.

- ***Interpolation and Contouring:*** Finally, the output "point" shapefiles from the settlement calculation are used to create contour shapefiles depicting the earthquake induced post-liquefaction vertical ground settlements for each earthquake scenario.

Detailed descriptions of the procedures for selecting boreholes, analyzing boreholes, calculating settlement, and creating contours with Spatial LIQUFAC are provided in Chapters 4, 5, 6, and 7 respectively. The user may run the settlement calculation and contouring routines repeatedly in order to asses many different earthquake scenarios with the same set of boreholes.

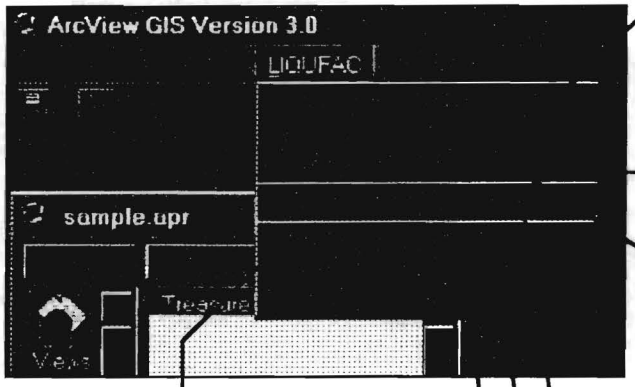
† ArcView® shapefiles are a simple, non-topological format for storing the geometric location and attribute information of geographic features. The shapefile format defines the geometry and attributes of geographically-referenced features in as many as five files with specific file extensions.

The Spatial LIQUFAC Process



The Spatial LIQUFAC Menu

Below is an illustration all of the functions available with Spatial LIQUFAC. The "LIQUFAC" pull down menu is available through the menu bars associated with ArcView®'s "project", "view", and "table" windows.



Starts a new analysis by erasing all info. in memory and creating a new borehole set.

Add one or more boreholes to the active set of analyzed boreholes.

Remove one or more boreholes from the active set of analyzed boreholes.

Allows user to enter the earthquake characteristics, calculate the settlement for the analyzed boreholes, and create an output "point" shapefile of the settlement at each borehole.

Performs the compilation of geotechnical engineering soil properties through a user controlled database query of the selected set of new boreholes to create the input files.

Creates contour shapefile of the settlement from the "point" shapefile.

Allows the user to view and print the output files created by Spatial LIQUFAC by opening the files in Windows '95® notepad.

CHAPTER 4: Selecting Boreholes

This chapter explains how to select a new set, or change the active set of boreholes to be included in the analysis.

- About the Treasure Island Geotechnical Database 13
- The Active Set of Analyzed Boreholes 13
- Selecting a New Set of Boreholes 14
- Adding New Boreholes to the Active Set of Analyzed Boreholes 15
- Removing Boreholes from the Active Set of Analyzed Boreholes 15

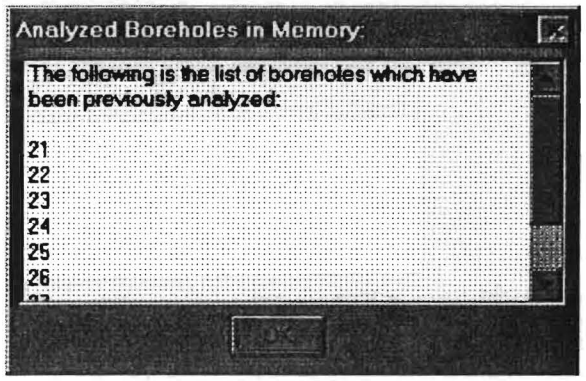
About the Treasure Island Geotechnical Database

The Treasure Island Geotechnical Engineering Database was originally compiled by Geomatrix Consultants and subsequently modified by The Georgia Institute of Technology. The database used in Spatial LIQUFAC Version 1.0 consists of 148 Standard Penetration Test (SPT) boreholes. These SPT boreholes were deemed the boreholes "most suitable" for geotechnical analysis. Of these 148 SPT boreholes, 18 are off-shore boreholes. (The elevation of the top of the borehole is below the elevation of the water table). The analysis routines integrated in Spatial LIQUFAC do not have the ability to deal with this condition so off-shore borings cannot be used in an analysis.

The Active Set of Analyzed Boreholes

The active set of boreholes is made up of boreholes which have been previously selected and analyzed. A borehole is not added to the active set until it has been selected and analyzed. The active set of analyzed boreholes in memory is displayed upon opening a project.

Hint: The user can also view the active set of boreholes by choosing "Add Boreholes" or "Remove Boreholes" from the "LIQUFAC" menu and then exit by pressing "Cancel".

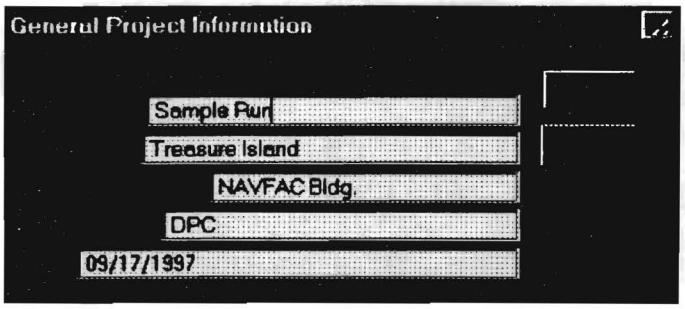


The user can change the active set of analyzed boreholes by choosing the "Select New Borehole Set", "Add Boreholes", or "Remove Boreholes" options from the "LIQUFAC" Menu.

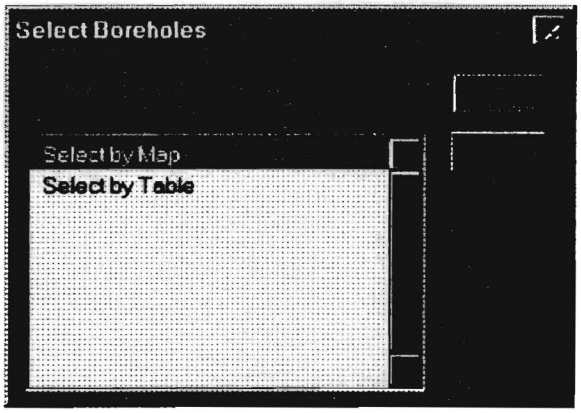
Selecting a New Set of Boreholes

To select a new set of boreholes and restart an analysis, simply select the "Select New Borehole Set" option from the "LIQUFAC" menu. This will erase the active borehole set from memory and set up a new analysis. Once this command is confirmed the previous boreholes list is lost permanently.

First, Spatial LIQUFAC will prompt the user to enter general information regarding the project. This information is stored in the header of the Spatial LIQUFAC input and output files so that previous projects can easily be recognized. The general information input box is shown below:



Next, the user will be asked to chose a method for selecting the active borehole set:



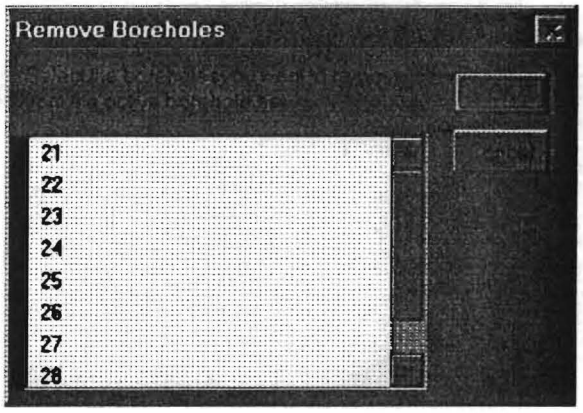
Spatial LIQUFAC then opens the appropriate windows and sets up the environment for selecting boreholes. You are not restricted to simply selecting boreholes with the mouse. All available methods for selecting records in ArcView® may be utilized. Once a set of boreholes is selected, they must be analyzed before the active set is saved.

Adding New Boreholes

Use this option to add one or more boreholes to the active set after the initial boreholes have been analyzed. The procedure for selecting additional boreholes is identical to that of selecting a new set. While using the "map" or "table" to select new boreholes, the boreholes which are already part of the active set of analyzed boreholes will be highlighted in yellow. Once additional boreholes have been selected, the user must analyze these boreholes before they are saved and added to the active set of analyzed boreholes.

Removing Boreholes

Use this option to remove one or more boreholes from the active set of analyzed boreholes. Simply choose the "Remove Boreholes" option from the "LIQUFAC" menu and then select the boreholes from the list of boreholes in the active set. The revised set is automatically saved. To reinstate boreholes which have been removed, you must use the "Add Boreholes" option. The "Remove Boreholes" window is shown below:



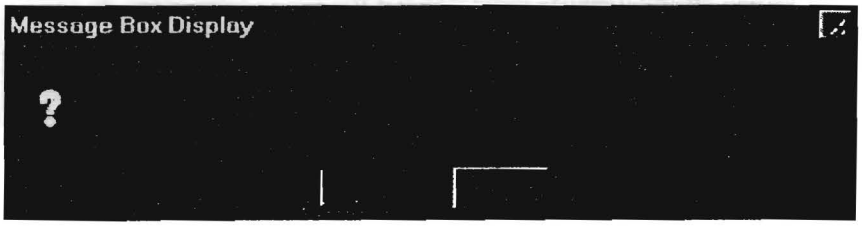
CHAPTER 5: Analyzing Boreholes

This chapter explains the details of the compilation of the geotechnical engineering soil properties.

- Message Box Display 17
- Borehole Stratigraphy Input 18
- Layer Analyses 19
  - ◊ Analysis Required 19
  - ◊ No Analysis Required 19
  - ◊ USCS 20
  - ◊ Unit Weight 21
  - ◊ SPT N - Values 22
  - ◊ Dynamic Soil Properties 24
  - ◊ G/G_{MAX} vs. Cyclic Shear Strain 25
  - ◊ Volumetric Compression 26
  - ◊ Percent Fines 27
- Displaying the Minimum Number of Message Boxes 28

Message Box Display

After the user has confirmed the selection of new borings to be analyzed, there are two possible methods for compiling the geotechnical engineering soil properties for the boreholes. The user may choose to view all of the input boxes required to compile the geotechnical data input or, they may choose to bypass the majority of input boxes and view the minimum amount of boxes.

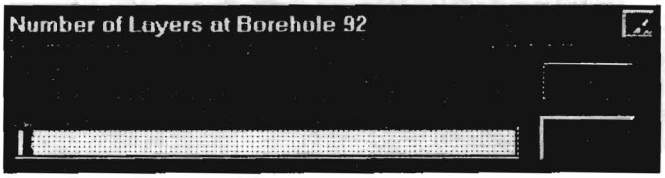


For inexperienced users it is recommended that all of the boxes are viewed. If "No" is selected and most of the boxes are bypassed, refer to the section on Displaying the Minimum Amount of Message Boxes located at the end of this chapter.

Borehole Stratigraphy Input

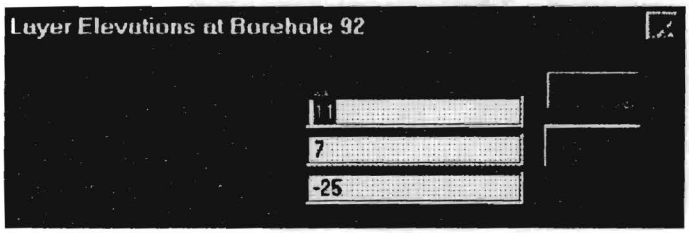
Spatial LIQUFAC reads the available data on stratigraphy from the geotechnical database and then displays it for the user to confirm. The user may choose to input different values than what is read from the database. For example, if there are four (4) layer actually present at a specific location where the database indicates three (3) layers, the user would specify four (4) layers and enter the appropriate elevations. Since Spatial LIQUFAC Version 1.0 has been designed to run specifically for Treasure Island, the defaults for stratigraphy have been set to those for Treasure Island.

First the user must select the total number of layers:



The Treasure Island default is three (3) layers: Hydraulic Fill, Young Bay Mud, and Old Bay Mud. Spatial LIQUFAC will allow for up to five (5) layers.

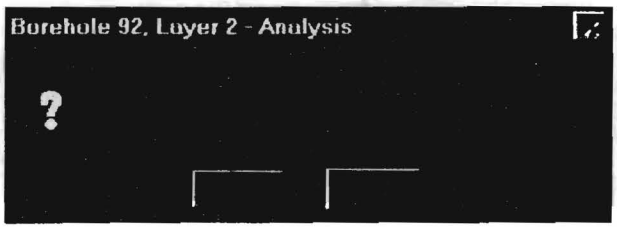
Next the user must enter the elevation at the top of each layer for this borehole:



To confirm the default selections, press "OK". The elevations are relative to the San Francisco Bay Mean Low Low Water (mllw).

Layer Analysis

Next, Spatial LIQUFAC compiles the data for each layer based on the stratigraphy for the borehole. First, the user must decide if liquefaction and settlement analysis is to be performed for this layer at this borehole.



Analysis Required

If "Yes" is selected Spatial LIQUFAC proceeds and performs the tasks for layer analysis outlined in this chapter.

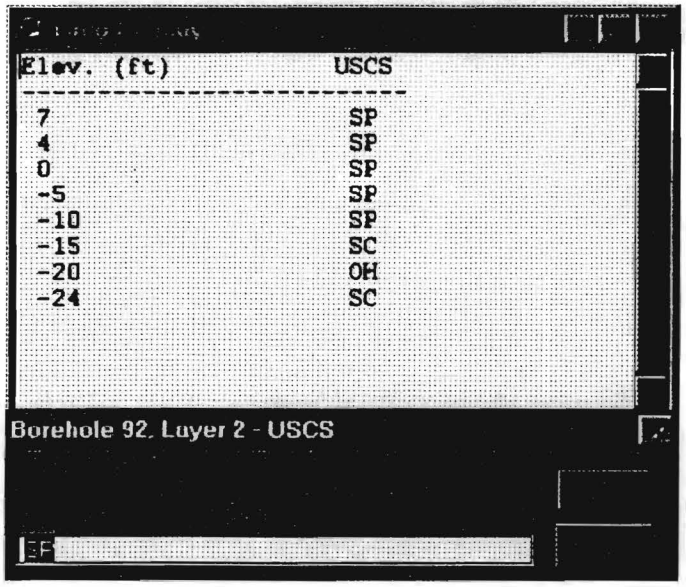
No Analysis Required

If analysis is not required for a layer, liquefaction potential and post-liquefaction settlement will not be calculated for this layer at this particular borehole. All of the following user inputs will be skipped and the analysis will proceed to the next layer. The user may be required to confirm or enter the unit weight for the layer not requiring analysis. The unit weight is required to calculate the overburden stress.

At this point Spatial LIQUFAC also checks to see if there are valid SPT N-Values available for the layer at this borehole. The N-Values are an essential part of the liquefaction calculations and analysis cannot be performed without them. If there are no N-Values available, no analysis is performed for this layer and the program proceeds to the next layer.

USCS

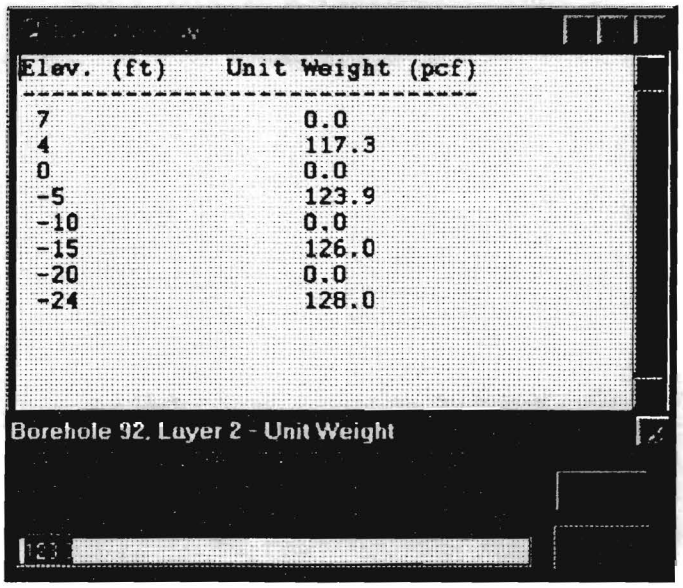
Next, the user is prompted to select a representative Unified Soil Classification System symbol for the soil layer at the borehole. The dialog is shown below:



The USCS symbol is merely used for display purposes in the Spatial LIQUFAC output file. The value entered here has no effect on the analysis. It may be left blank or set to "NA" for not available.

Unit Weight

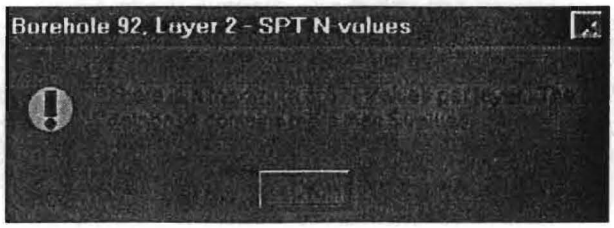
The dialog for entering the soil unit weight for a layer is shown below:



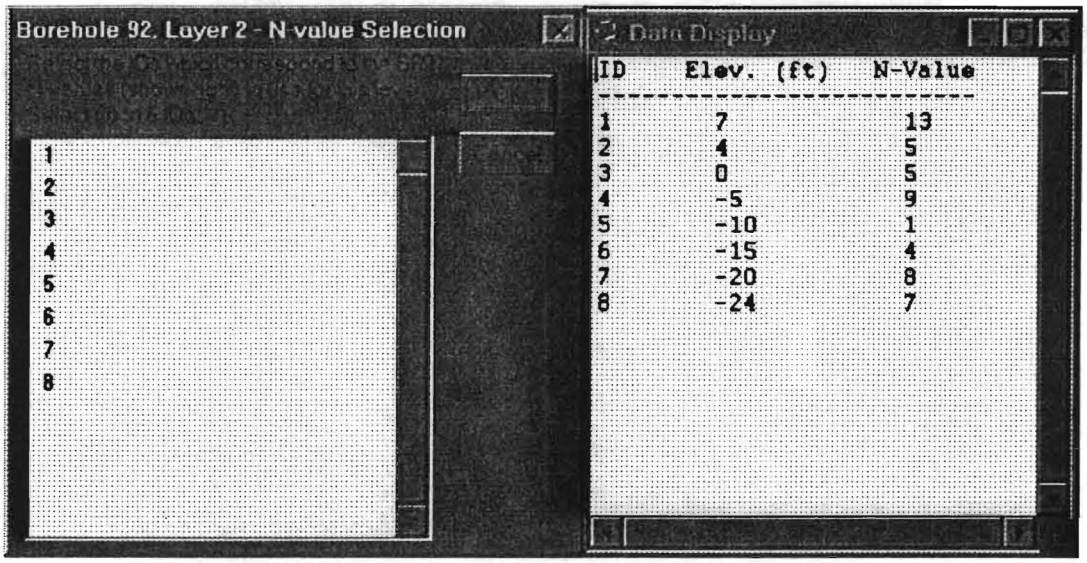
This value is the wet unit weight of the soil. The default value is set to the average of the non-zero values for the unit weight in the database. If there is no value available for the unit weight in the database, the user is asked to assume a value for the layer at this borehole.

SPT N-Values

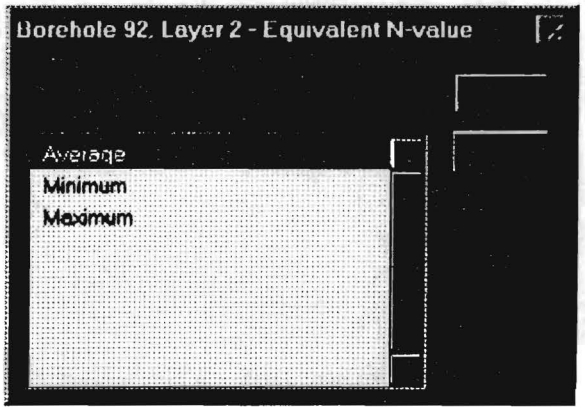
The available SPT N-Values for a layer are read automatically from the geotechnical database. However, Spatial LIQUFAC can only accept up to five (5) SPT N-values per layer. If there are more than five (5) available N-Values in the geotechnical database the following message box will appear:



Pressing "OK" will bring up the next message box which prompts the user to select between one (1) and five (5) N-Values for the layer.

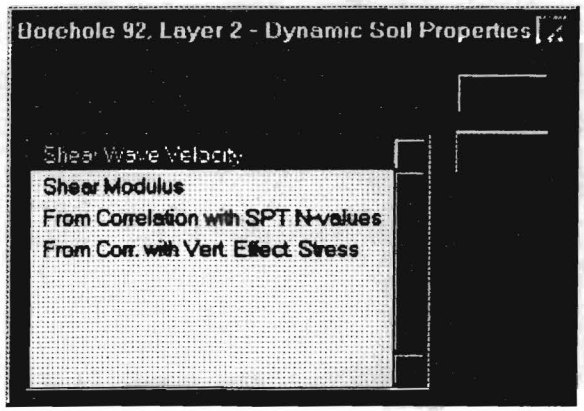


Next, the user must select the method to calculate the equivalent SPT N-Value for the layer using the dialog box shown below:



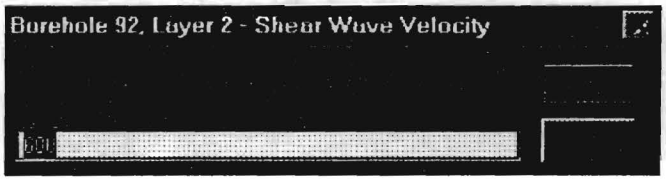
Dynamic Soil Properties

The dynamic properties of the soil layer are an important parameter in calculating the liquefaction potential and post-liquefaction induced vertical settlement. The user has four (4) different methods to input the dynamic soil properties. The dialog box is shown below:

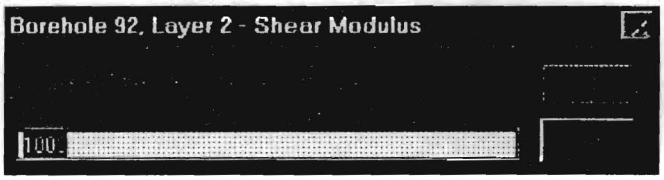


After selecting a method, the user must enter the required values for that method.

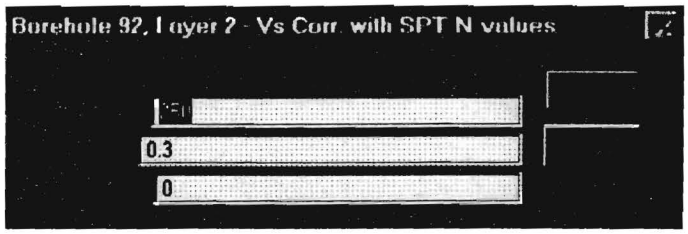
Shear Wave Velocity:



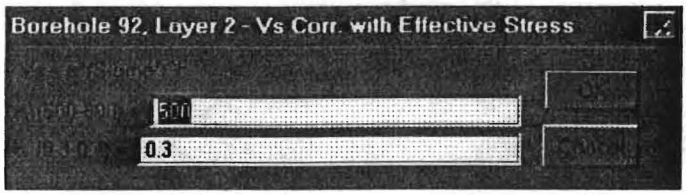
Shear Modulus:



Shear Wave Velocity Correlation with SPT N-Values:

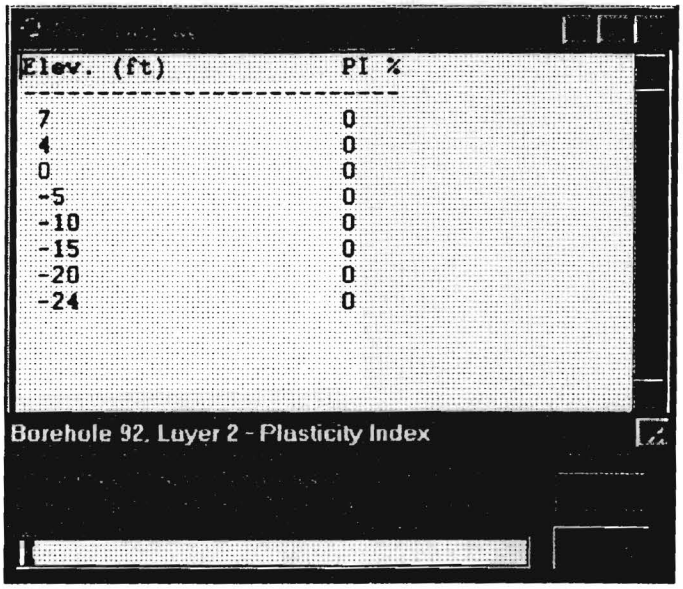


Shear Wave Velocity Correlation with Effective Stress:



G/G_{MAX} vs. Cyclic Shear Strain

To calculate G/G_{MAX} vs. Cyclic Shear Strain Spatial LIQUFAC uses the curves developed by Vucetic and Dobry (1991) which use the plasticity index of the soil. The plasticity index is input using the dialog box shown below:

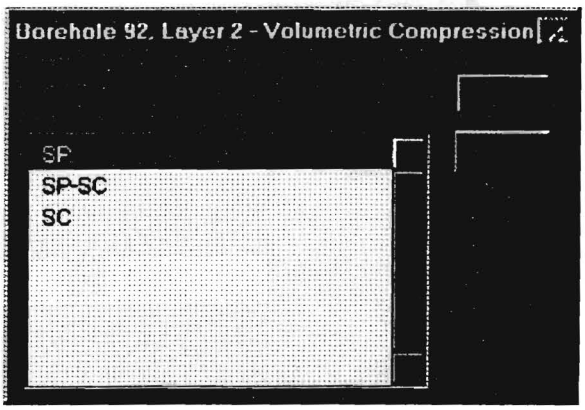


Elev. (ft)	PI %
7	0
4	0
0	0
-5	0
-10	0
-15	0
-20	0
-24	0

A zero (0) can represent either that there is no data for this sample or that the acutal PI was equal to zero. The default plasiticity index is set to zero percent (0%).

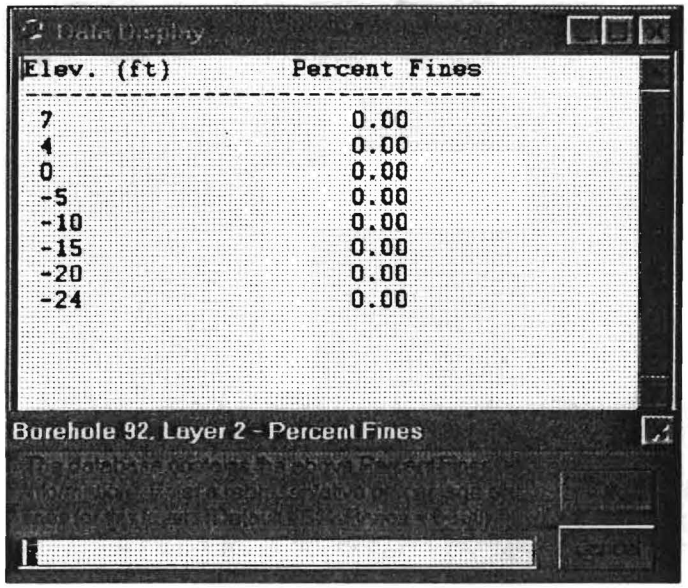
Volumetric Compression

The volumetric compression of the soil in a layer is calculated using the curves which define a relationship between the volumetric compression and the cyclic shear strain. There are curves for three (3) different soil types. The dialog box for selecting which soil type to base the relationship on is shown below:



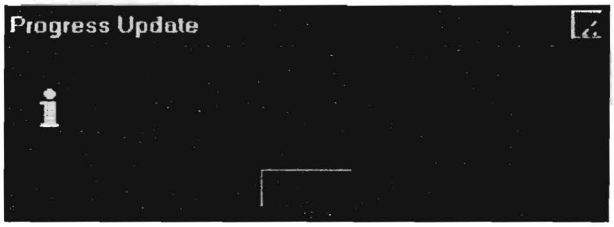
Percent Fines

Spatial LIQUFAC calculates the liquefaction resistance of sand using the method developed by Seed et al (1984) which incorporates the percentage of fines in the sand. The dialog box for entering the percent fines for the soil layer is shown below:



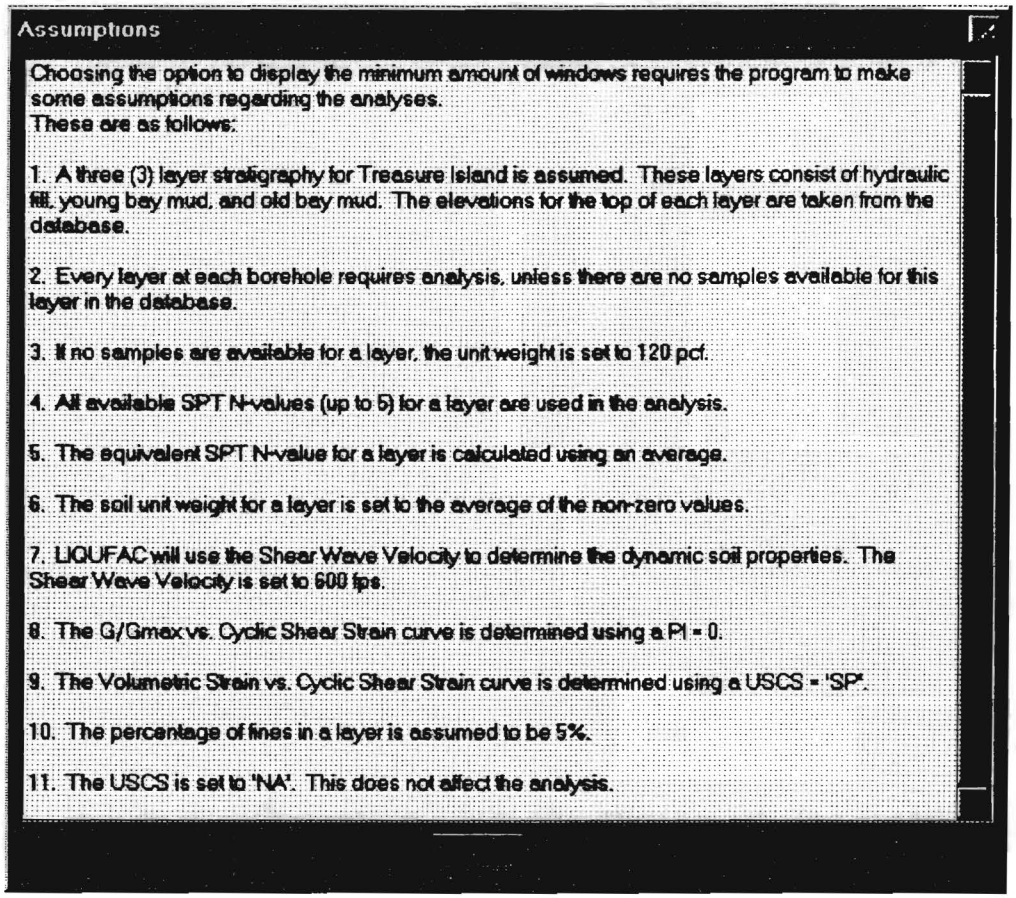
A zero (0.00) represents either 0% fines or no data is available for that sample.

Upon completion of the compilation of data for the layer, Spatial LIQUFAC repeats the analysis for each layer in the borehole. After each borehole is complete Spatial LIQUFAC informs the user of its progress before proceeding to the next borehole. An example is shown below:



Displaying the Minimum Number of Message Boxes

If the user chooses to not display all of the input message boxes that are generated while analyzing a set of boreholes, Spatial LIQUFAC makes some decisions regarding the information obtained from the geotechnical database for each borehole. These assumptions are stated when the user selects "No" in the "Message Box Display" window.



If you do not wish to make all of these assumptions, you must view all of the message boxes.

Hint: If you wish to analyze a large number of boreholes and you only need to view the message boxes for a few of the boreholes, do the following. First, select a new borehole set consisting of the boreholes that you do not need to view all of the message boxes. Analyze these boreholes. Next, add the boreholes for which you would like to view all of the message boxes and then analyze them. The active set of boreholes will now consist of both sets of boreholes.

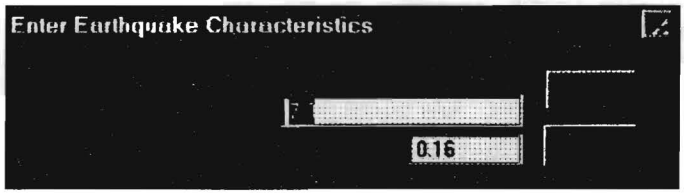
CHAPTER 6: Calculating Settlement

This chapter explains the how to calculate the liquefaction potential and post-liquefaction vertical settlement, and create an output point shapefile of the settlement at each borehole.

- Defining the Earthquake Characteristics 30
- Running Spatial LIQUFAC to Create the Settlement Shapefile 30
- Viewing the Spatial LIQUFAC Output Files 30

Defining the Earthquake Characteristics

The "Caclulate Settlement" option under the "LIQUFAC" menu allows the user to input the earthquake magnitude and peak ground acceleration and then Spatial LIQUFAC calculates the vertical settlement at each borehole for the input earthquake scenario and stores the results in a point shapefile.



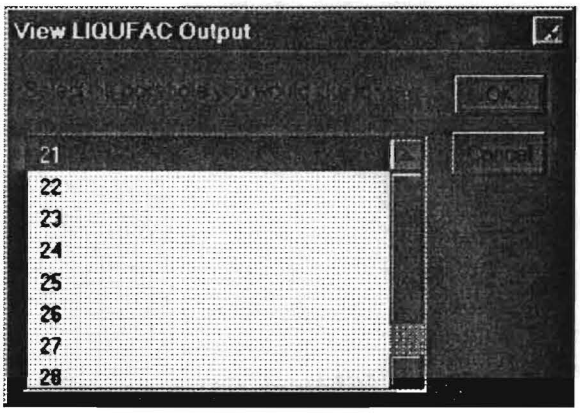
Running Spatial LIQUFAC to Create the Settlement Shapefile

After, the earthquake information is input, and Spatial LIQUFAC has been run, the user is asked to input a filename for the output settlement shapefile. This file can be stored anywhere, however, it is recommended that all output shapefiles be stored in their respective projects folder.

This process may be repeated for several different earthquake scenarios.

Viewing the Spatial LIQUFAC Output Files

To view the output from Spatial LIQUFAC for a particular borehole, select the "View LIQUFAC Output" option from the "LIQUFAC" menu. Then select the borehole you would like to view.



Spatial LIQUFAC opens the output file for the selected borehole using the Windows '95® Notepad. The output file may be printed by selecting the "Print" option from the Notepad "File" menu. To return to ArcView®, close the Windows '95® Notepad. It is not necessary to save the file.

An example of viewing the output file using Windows '95® Notepad:

boring92.out - Notepad

```
                                   LIQUFAC
                     -- Liquefaction Potential Analysis --
                                by NAVFAC/IDI/PEI


          Project Title:       Sample Run
          Project Site:        Treasure Island
          Proposed Structure:  Navfac Bldg.
          Date:                9/17/1997
          Computed By:         DPC

============================  Factor of Safety  ==================

No      SPT       Soil Elev.   %     Cyclic Stress Ratio      Fs
   -------------                     --------------------  Against
   N N(60) N1(60)     (ft)  Fines  Ri(Design) Rf(Liquef)  Liquef
1                     11.0
1   6  6.0   9.6       8.5
1            9.60 NA          5.0      0.104     0.117     1.125

2                      7.0
2   5  5.0   6.8       0.0
2   9  9.0  10.8      -5.0
2   1  1.0   1.1     -10.0
2   4  4.0   4.0     -15.0
2   8  8.0   7.5     -20.0
2            6.05 NA          5.0      0.149     0.072     0.484

3                     -25.0
3   0  0.0   0.0     -25.0
```

CHAPTER 7: Creating Contours

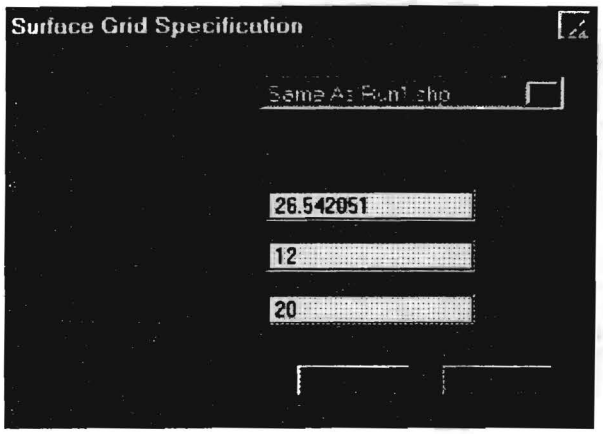
This chapter explains the how to create a contour shapefile of the vertical settlement from the point shapefile generated by Spatial LIQUFAC.

- Creating Contours of the Vertical Settlement 33

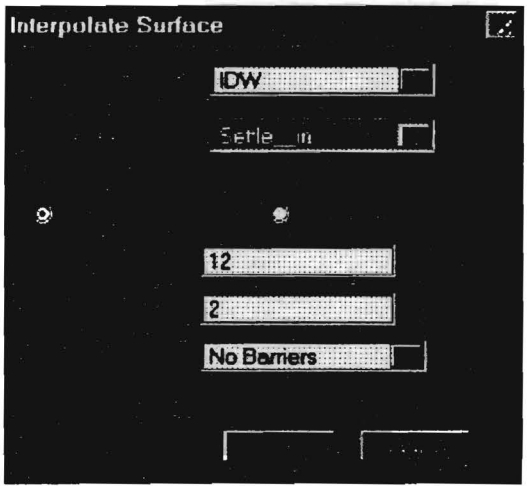
Creating Contours of the Vertical Settlement

To draw contours of the post-liquefaction induced vertical settlement, select the "Create Contours" option from the "LIQUFAC" pull down menu. You will then be prompted to select the name of the point shapefile to create the contours from. This is one of the output point shapefiles that Spatial LIQUFAC created while calculating the settlement. There should be a different output shapefile for each earthquake scenario that you ran. Select one of these shapefiles and press "OK".

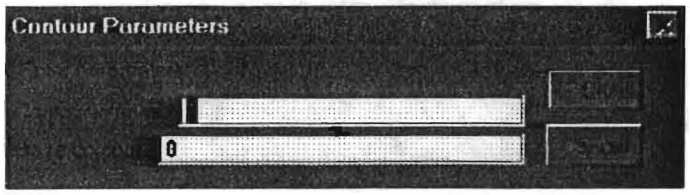
Next, the "Contours" dialog box will be displayed showing several different options available for creating contours:



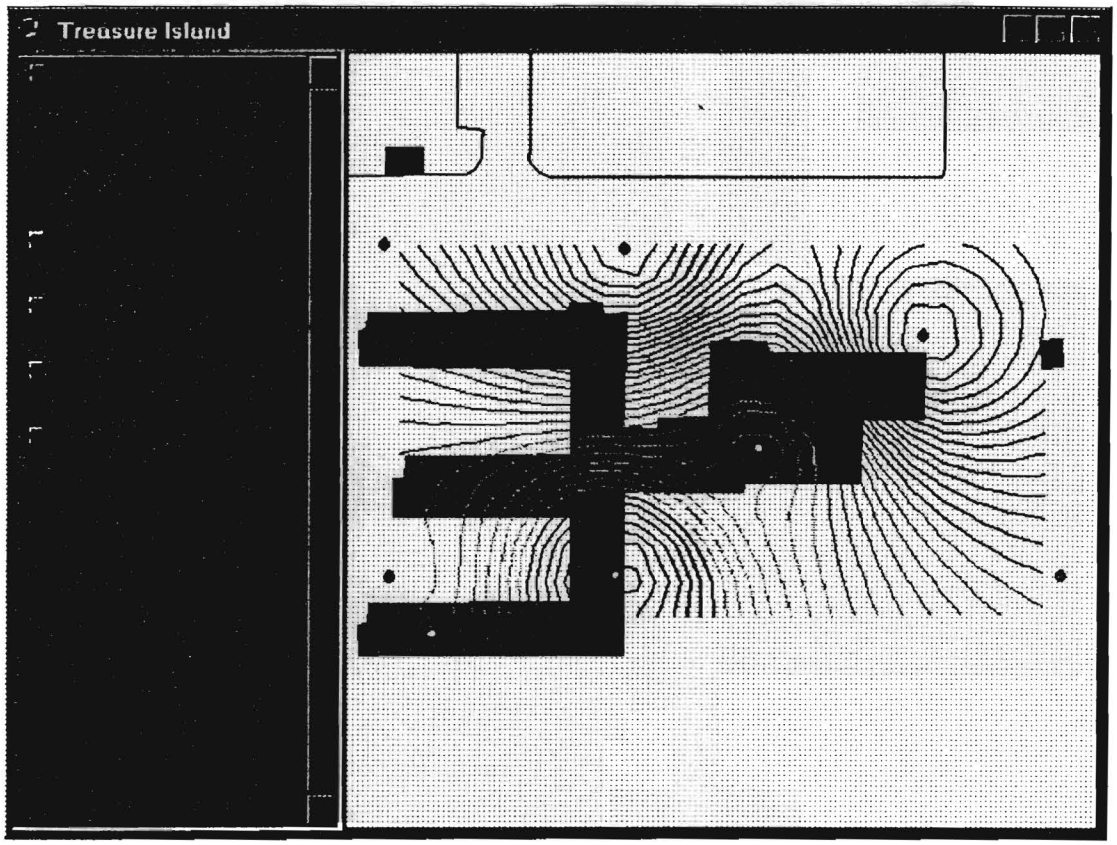
Set the Output Grid Extent to "Same As <the name of the settlement shapefile>" and then press "OK". ArcView® then displays the next dialog box:



Choose which method you wish to use to interpolate the surface (Inverse Distance Weighted or Spline) and select "settle_in" as the Z Value Field. You are then asked to specify the contour interval and the base contour.



ArcView® then creates a contour shapefile. An example is shown below:



For more details on creating contours with ArcView®, please refer to the ArcView® On-Line help.

CHAPTER 8: Sample Run

This chapter shows the input and output of an sample run that was performed for Treasure Island using Spatial LIQUFAC.

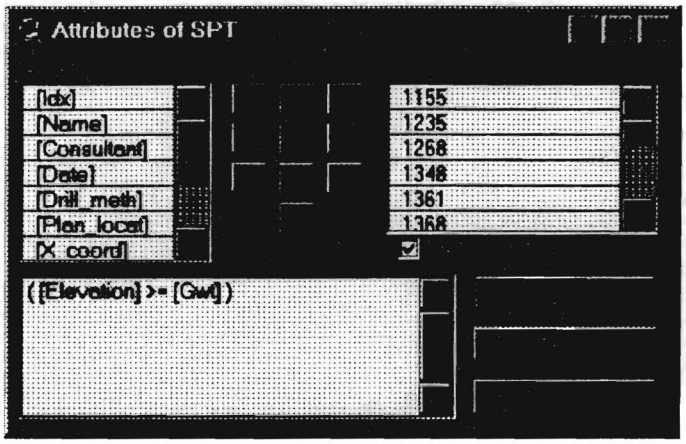
- Description of Analysis 36
- Borehole Selection 36
- Borehole Analysis 37
- Results 38

Description of Analysis

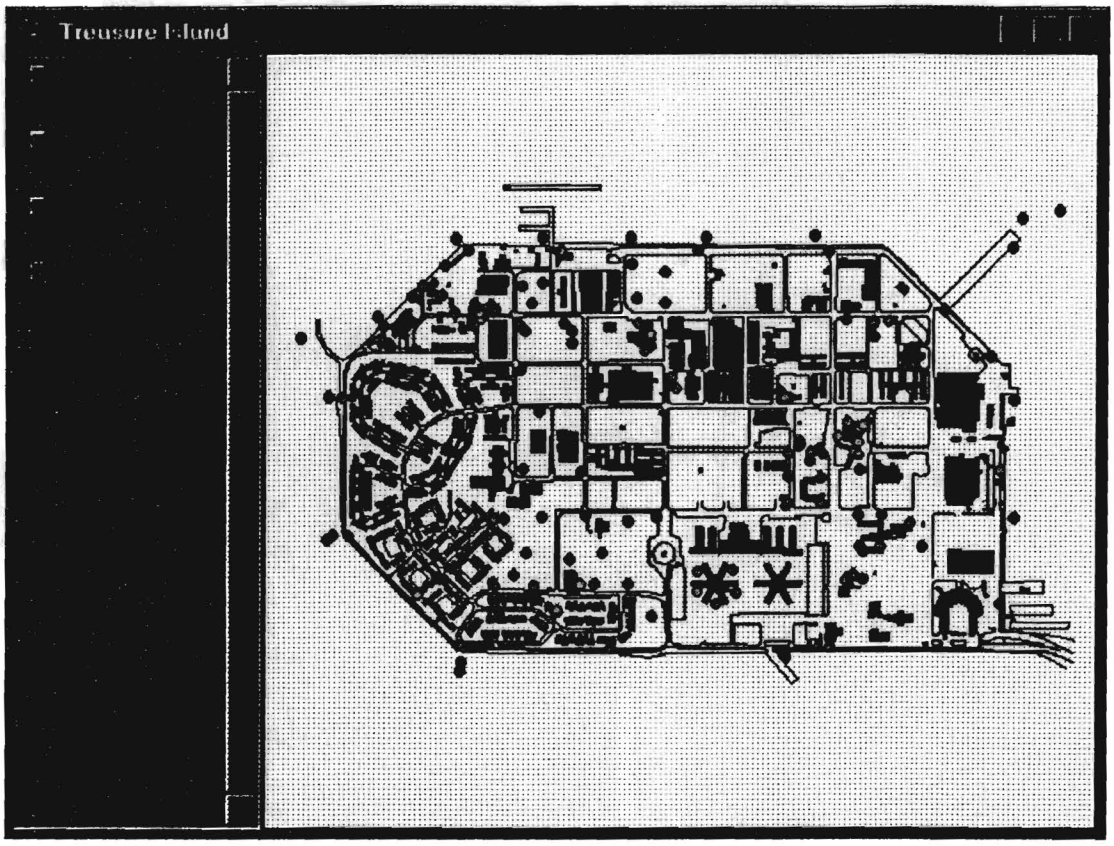
The following describes an analysis of the earthquake induced post-liquefaction vertical settlement at Treasure Island Naval Facility for a earthquake with a magnitude of 7.0 and a peak ground acceleration of 0.16 g's. The analysis will include all of the above water level boreholes.

Borehole Selection

First, the appropriate boreholes must be selected. To accomplish this, a query was used to select all of the boreholes with elevations greater than the ground water elevations. The query builder available in the ArcView® "Table" menu used is shown below:



The resulting selection is 130 of 148 available boreholes. The selected boreholes are shown on the map on the next page.



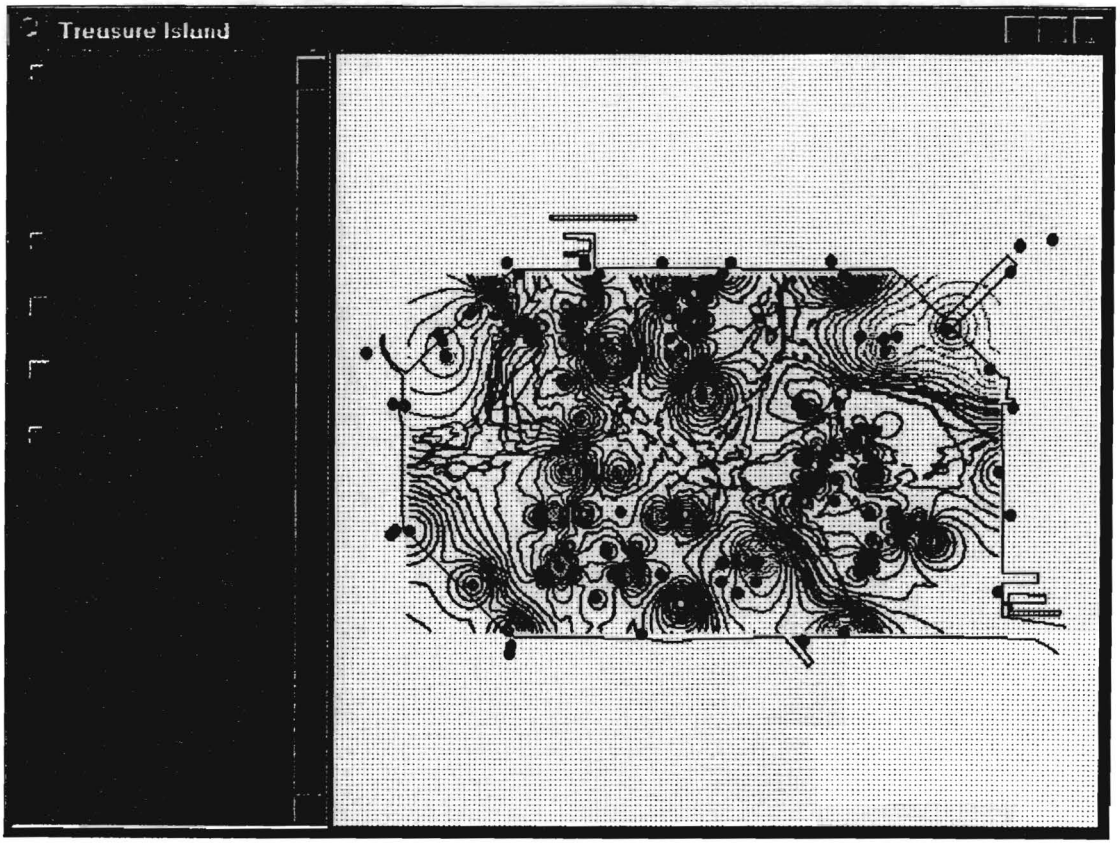
Borehole Analysis

Analysis was performed on the active set of Treasure Island boreholes using the following assumptions:

- The Old Bay Mud layer was not analyzed since it is not likely to liquefy.
- The dynamic shear properties of the soil were specified by a shear wave velocity equal to 511 ft/sec for the hydraulic fill and 603 ft/sec for the Young Bay Mud.
- The curve used for the Volumetric Compression vs. Cyclic Shear Strain was selected based on the best available USCS classification for the layer. If no USCS classification was available, the SP curve was used.
- The unit weight was set to 120 pcf if no data was available.

Results

The resulting settlement contours for M=7.0 and a=0.16 g's are shown below.



APPENDIX A: Database Legend

Below are two tables which describe some of the symbols and abbreviations used in the geotecnical database.

Symbol	Consultant Name
1	PAL Consultants
2	Woodward-Clyde Consultants
3	Harding Lawson Associates
4	Rutherford & Chekene
5	McCreary-Koretsky Engineers
6	GEO/Engineering Consultants
7	Tejima and Associates
8	Geo/Resource Consultants
9	Associated Geotechnical Engineers
10	Terratech Inc.
11	Taber Consultants
12	Harlan Miller Tait Consultants
13	Geomatrix Inc.

Symbol	Drill Method
AUG	Auger
RT.WS	Rotary Wash
WS.BR	Wash Boring

APPENDIX B: References

Vucetic, M. and Dobry, R. (1991) "Effect of Soil Plasticity on Cyclic Response", Journal of Geotechnical Engineering, Vol 117, No. 1.

Seed, H. B., Tokimatsu, K., Harder, L. F., and Chung, R. M. (1984) *The Influence of SPT Procedures in Soil Liquefaction Resistance Evaluation*, Report No. UBC/EERC-84/15, Earthquake Engineering Research Center, University of California, Berkeley, CA.